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AFB PUBLICATIONS

Talking Book Department

RECORDING SCIENCE TEXTS FOR THE BLIND

American Foundation for the Blind
15 West 16th Street, New York 11, N. Y.

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RECORDING SCIENCE TEXTS FOR THE BLIND

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New York

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This pamphlet is one in a series of monographs issued from time to time by the American Foundation for the Blind in an attempt to disseminate information on projects carried out by the Foundation and on present-day services to blind persons. The monographs are classified according to subject into:

1. General Information
2. Preschool Series
3. Educational Series
4. Vocational Series
5. Research Series
6. Group Reports
7. Legislation Series

The description of the copper atom on Page 8 is quoted by permission from *Essentials of Electricity for Radio and Television,* by Slurzberg and Osterheld. Copyright 1950, by McGraw-Hill Book Company, Inc.

Price 50 cents

Published July 1957 by the
AMERICAN FOUNDATION FOR THE BLIND
15 West 16th Street, New York 11, N. Y.

Printed in U.S.A.
The William Byrd Press, Inc.

FOREWORD

In 1951 the American Foundation for the Blind issued a publication entitled *Recording Books for the Blind.* Its contents included proved practices and specific ways of solving some of the problems encountered by those who record for blind persons. However, the recording of highly scientific material effectively still constituted a major problem. In its attempt to solve this continuing problem, the American Foundation for the Blind in 1956 awarded a financial grant to Dr. Thomas A. Benham for the purpose of recording *Science for the Blind.* One of the stipulations of the grant was that there be developed a helpful manual on recording science texts for blind persons. To that end, the AFB named an Advisory Committee as follows: Dr. Thomas A. Benham, Professor of Physics, Haverford College; Mr. John Dupress, Chairman, Committee on Electronics Aids and Devices for Blinded Veterans, Blinded Veterans Association; Dr. Clifford M. Witcher,* Research Laboratory of Electronics, Massachusetts Institute of Technology; also, ex officio, Miss Kathern F. Gruber, Assistant Director, American Foundation for the Blind, and Mr. Arthur Helms, Production Manager, Talking Book Studios, American Foundation for the Blind.

The procedures and suggestions which appear in this publication were made possible largely through the direct experience of Dr. Benham in his actual recording of scientific material. His work was supplemented by the deliberations of the Advisory Committee meeting in frequent sessions. Mr. Arthur Helms edited the final manuscript.

In issuing this publication, the AFB hopes to be of direct assistance to the many readers who may be recording scientific material for blind persons, and of indirect assistance to many blind persons to whom technical material, we hope, will be more effectively and uniformly communicated for their listening pleasure and profit.

M. R. Barnett
EXECUTIVE DIRECTOR

* Dr. Witcher passed away October 6, 1956.

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PART I

REQUIREMENTS

What Are You Trying to Do?

Your job as a reader of science texts for the blind is to provide the listener with a complete, accurate sound recording of a printed book—a recording that is at all time comprehensible to the ear. In performing this task you should put yourself in the position of a lecturer on the radio whose effectiveness depends (with certain exceptions we shall discuss) on the spoken word alone. When you have finished a job, you should be able to guarantee the listener that the recording in his hands gives him everything that is available to the sighted reader of the same text.

Qualifications for Reading

The basic requirements for any sort of reading aloud are: a voice at least moderately agreeable and free from distracting mannerisms; intelligibility; and the ability to interpret orally (See *Recording Books for the Blind.)* The essence of oral interpretation is phrasing. You must be able by the use of pause and emphasis to make the author's meaning unmistakably clear to the listener.

For reading science material there are additional requirements. You need not be an advanced student of the subject, but it is desirable that you have some understanding of and interest in general science. It is also desirable that you be familiar with the formulas and symbols of mathematics, physics, and chemistry, but, if professional help in rendering these verbally is available, you need have only an elementary knowledge.

Fully as important as any of the foregoing requirements, however, is the ability to use your imagination. Since your object is to translate visual into auditory symbols, you will be required to think in a medium (sound) which, although normally secondary for you, is primary for the listener. This involves a persistent effort of imagination. You must always be sure that your words *as*

sound carry the same meaning to the listener as the printed words carry to a sighted reader. You will in particular be frequently faced with the problem of presenting graphic material (diagrams, etc.) by words alone—a task often calling upon all the resources of your imagination. In short, imagination and ingenuity are as important to your job as reading ability and an elementary understanding of the subject.

NOTE: *Not all graphic material can be successfully described in words. The problem of providing braille diagrams is taken up in Appendix A.*

Editing

Apart from the actual reading of the text into a microphone your job is almost wholly one of editing. As used here, the term "editing" means the additions, omissions, or changes you may make in a text to render it comprehensible to a listener, and the tactual material you may furnish for the same purpose. Specifically, it includes:

Announcements
Explanation of graphic material (including the furnishing of tactual aids)
Spelling
Reading equations and formulas
Reading footnotes and references

We will devote the remainder of Part I to saying a few words about each of these, and in Part II and the Appendices we will give specific examples of how to handle them.

Announcements

At the very beginning of the recording, that is, at the beginning of the first recorded unit (side, track, or reel), an announcement gives the title of the book, the name of the author, the publisher, and the copyright owner; it states that permission to record has been granted; and it gives any special instructions on how to use the recording and the braille supplements, if any. This

announcement should be followed by a reference to the table of contents. (See below.)

Every subsequent recorded unit must have an announcement at the beginning and at the end. The one at the beginning should tell the number of the side, track, or reel, and its contents in terms of chapter numbers, chapter titles, and book page numbers. The one at the end should tell the listener to turn over the record, use the next record, reverse the reel, or use the next reel, as the case may be.

Explanation of Graphic Material

As we have already pointed out, a major part of your editorial work will be to determine how to interpret graphic material. "Graphic material" refers to illustrations, diagrams, graphs, charts, tables, symbols—in fact to any material *that is not words in ordinary sentence form*. Your problem will be, with the aid of the fundamental examples given in Part II, to make such material intelligible to the listener.

(It should be noted that while most graphic material will require oral or tactual interpretation, there are times when you may omit any reference whatsoever to an illustration, diagram, etc. For example, a diagram explained in such a way by the text that the point is clear without a description of the diagram itself need not be mentioned. Furthermore, photographs of factories, products, processes, etc., common in school texts, may often be omitted, although occasionally, if by a terse description you can convey an idea of the relative size of an illustrated object or layout, it may be worth while to do so.)

In general, you should describe graphic material orally whenever possible. There are, unquestionably, numerous cases (for example, the representation of a sine wave) in which words alone are not sufficient, and you should resort to tactual aids. It is always desirable to illustrate fundamental scientific concepts tactually, but when you can make a clear explanation in words alone, do so. Verbal explanation, properly handled, can clarify things a great deal more than you perhaps suppose. It can, as you will see in Appendix B, make quite complicated structural formulas intelligible. It is highly advisable for readers of scientific material to

make the effort to master the art of explaining visual concepts in words.

Reading Equations and Formulas

Since equations and formulas are absolutely essential in most of the sciences, great care should be taken to render them accurately. There must be no doubt in the listener's mind as to what the equation or formula states. The detailed study of this subject in Part II will give you a firm grasp of the method, but if in your reading work you are faced with a problem you cannot solve, the best procedure will be to consult a professional in that field. The two of you can then phrase and rephrase the equation or formula until you are both satisfied that it is clear.

Reading Footnotes and References

Authors' footnotes that amplify an explanation or make an interesting point should be included. Introduce such notes with the words "author's footnote" and conclude with the words "end of note." References to other texts, to magazine articles, etc., should be included, as should bibliographies.

PART II

EXAMPLES

The following series of examples illustrates step by step the editorial tasks described in Part I. These examples cover most of the problems you will encounter. Enevitably, in actual practice situations will arise that no handbook, however thorough, could possibly anticipate. It is then that you will have to depend on imagination and ingenuity.

Announcements

Opening announcement—beginning of first recorded unit:

> "*Essentials of Electricity for Radio and Television* by Morris Slurzberg and William Osterheld. Copyright 1950 by the McGraw-Hill Book Company, Inc. Recorded solely for the use of the blind with the permission of the publisher and copyright owner, the McGraw-Hill Book Company, Inc."

This is the absolute minimum of information to be given in an opening announcement. You *must* give full title, name of author, copyright owner, and statement to the effect that the book is recorded by permission. (For details on obtaining permission and writing credit lines, see Part III, the section. . . . "Obtaining Permission to Record.") You *may* add your own name and/or that of the organization producing the recording:

> "Read by Tom Smith. Produced by the Student Volunteer Service of Woodstock College."

(If the author's name is an unusual one, spell it in the opening announcement so that the listener will be clear on this form the start:

> "*Plastics from Farm And Forest,* by E. F. Lougee, L-o-u-g-e-e"

Such is the opening announcement proper. Next should come an explanation of editorial additions, etc.

> "The text of this book has not been altered, but additions have been made wherever it was thought that the text in inkprint did not convey the meaning to a listening audience. Diagrams are described in detail and the more complicated ones are also supplied in braille. In all cases diagrams are designated by the same numbers used in the book. All remarks inserted by the reader are prefaced by the words 'note to the listener' and closed with the words 'end of note'."

(A word of caution about remarks inserted by the reader: *Never ad lib such remarks. Write them out beforehand.*)

Announcement at the beginning of a recorded unit:

"Side 17 .....*Basic Chemistry*"	(disk recording)	or
"Reel 4 .....*Elements of Electricity*"	(tape recording single track)	or
"Reel 8, Track 2 ...*Gray's Anatomy*"	(tape recording double track)	

This announcement identifies the disk, side, or reel track. But it is still not complete. It must also describe the contents:

> "Reel 3, Track 1. *Essentials of Electricity for Radio and Television,* page 72, Chapter 5, Magnetism—continued."

The reference to the book page number on every recorded unit announcement orients the listener in relation to the printed text. He thus has a basis for reference in discussions with instructor, fellow-students, or sighted aid.

Announcement at end of a recorded unit:

"Continued on the other side"	(end of first side of each disk)	or
"Continued on the next record"	(end of second side of each disk)	or
"Continued on the next reel"	(tape, single track)	or
"Continued on the other track of this reel"	(tape, double track, end of first track)	or
"Continued on the next reel"	(tape, double track, end of second track)	

Final closing announcement:

> "The end. Recorded by (name of organization). Read by (your name). Date."

Table of Contents

As noted in Part I, an opening announcement should be followed by a reference to the table of contents. (A table of contents lists chapter numbers and titles, appendices, etc., and tells on which recorded unit they are to be found.) It will be seen at once that you cannot record the table of contents until you have done the whole book, because you do not know what side or reel the various chapters will fall on. You will therefore have to record it afterward and then incorporate it at the beginning or the end of the text.

When everything is taken into consideration, it is recommended that the table of contents be placed at the *end* of the recording on a separate reel or side of a disk, and that it form a unit in itself. Inserting it after the opening announcement (which might seem the logical course because it appears in that position in the printed book) involves a complicated editing job. But aside from that, the fact is that most students will not have occasion to refer to the table of contents until they have finished listening and wish to refer *back* to the text. By placing it at the end and separate from the rest, you furnish a convenient, easily consulted guide.

Immediately after the opening announcement tell the listener where the table of contents is to be found. For example:

> "The last side (or reel), number 22, contains a detailed table of contents."

Now let's consider a typical recorded table of contents:

> *"Contents:*
>
> Reel 1, Track 1 (or Side 1), pages 1 to 28, contains Chapter 1, Communication; Chapter 2, Basic Theory of Electricity; and about the first third of Chapter 3, Batteries.
> Reel 1, Track 2 (or Side 2), pages 28 to 50, contains the last two thirds of Chapter 3, Batteries; Chapter 4, Electric Circuits; and about the first half of Chapter 5, Magnetism.
> Reel 2, Track 1 (or Side 3), contains pages 50 to 72, last half of Chapter 5, Magnetism; Chapter 6, Radio Waves, etc."

With such a table the listener can find major subject headings

with relative ease. (It should be noted that, when you are recording the text and come to a new chapter, you should give the book page number, as, "Chapter 3, Batteries, page 35.")

Explanation of Graphic Material

We have now to consider the translation of graphic material into auditory terms. First let's recall our remark that simple diagrams fully explained by the text need not be mentioned. Figure 1

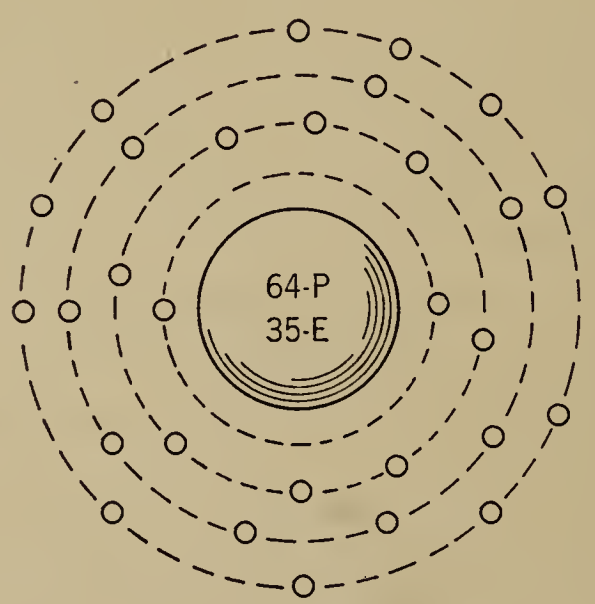


Figure 1. Structure of copper atom.

is an instance. It is a diagram of an atom of copper. In the book in which it appears the relevant text reads as follows:

> "The atom of copper has 64 protons and 29 orbital electrons. These electrons will require 4 orbits, which will have 2, 8, 8, and 11 electrons respectively."

In this case, since the protons have already been described and are understood to constitute the nucleus, no description of the diagram is necessary. To give the listener an adequate image, all you have to do is insert the words "proceeding from the center outward" between the words "have" and "2."

Figures 2 and 3 are two examples of relatively simple diagrams that are not explained by the text. They will therefore require description.

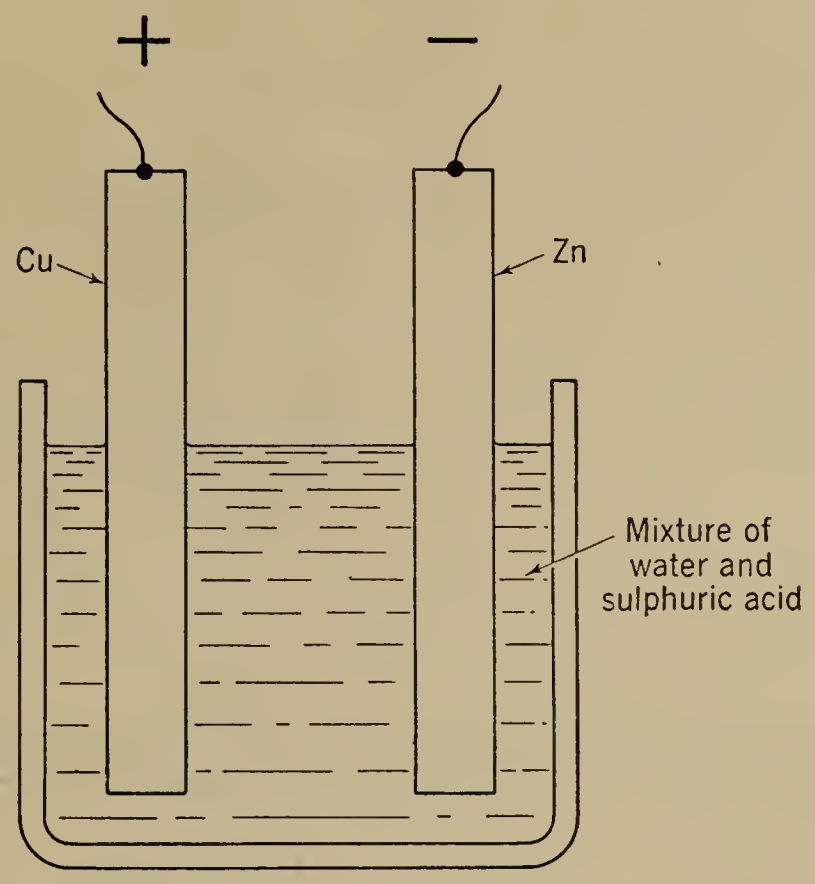


FIGURE 2. Simple voltaic cell. (By permission, from *Essentials of Electricity for Radio and Television,* by Slurzberg and Osterheld. Copyright 1950 by McGraw-Hill Book Company, Inc.)

Figure 2 may be described as follows:

> "Figure 2 shows a cross-section of a vessel shaped like the lower half of an ordinary jar. In the vessel is a liquid labeled 'Mixture of water and sulphuric acid.' Standing vertically in the liquid, but not touching each other or the sides of the vessel, are two rods, one marked 'copper, plus,' the other marked 'zinc, minus'."

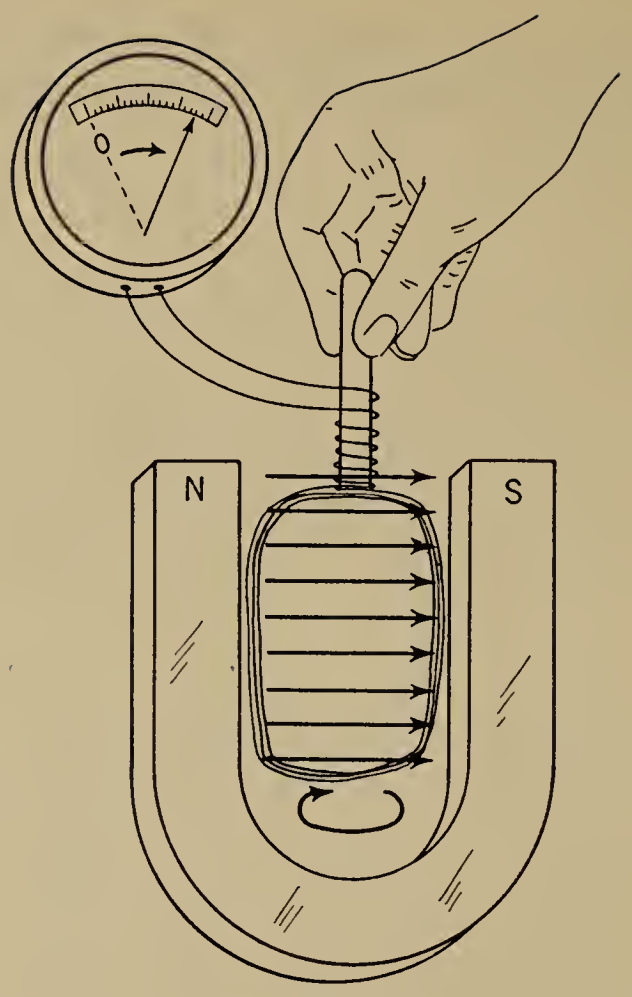


FIGURE 3. A simple AC generator. (*High School Physics,* by Blackwood-Herron-Kelly, Ginn and Company.)

You could describe Figure 3 this way:

> "An iron bar magnet bent in the shape of the letter U is shown standing upright. Above, a hand holds a rod pointed downward. Attached to the bottom of the rod is a stiff coil of wire which is being suspended within the sides of the U with the plane of the coil vertical. The rod joins the middle of one side. Two wires (the terminals of the coil) run off to a galvanometer above. The caption says, 'A simple alternating current generator. By rotating the coil you make its windings cut magnetic lines and thus generate a current'."

These examples give a perfectly clear image .The description is simple and concrete. (Incidentally, when describing diagrams, resort wherever possible to comparisons with familiar objects—like the lower half of a jar and the letter U.)

Sooner or later you will reach the point where at least some of your graphic material is beyond words and you will have to resort to tactual methods. Go as far as you can with description as long

as you can make it clear. When you have any doubts about the effectiveness of words, use other methods. (See Appendix B.)
pause.

Spelling

As a general rule, spell a word immediately after its first occurrence. Do it parenthetically, as it were, and without inserting such words as "that is spelled." Spell by syllables. In the following examples the number of dashes indicates the relative length of the

> The sentence in the book reads: "One of the gases that causes sneezing is diphenylchlorarsine." You read: "One of the gases that causes sneezing is diphenylchlorarsine, d-i--p-h-e-n-y-l--c-h-l-o-r--a-r-s-i-n-e."

However, if the position of a word in a sentence is such that to stop and spell it would break up the thought, you can do this:

> The book reads: "When molybdic acid (H_2MoO_4) is heated, it breaks down into water and the oxide MoO_3." You read the sentence as it stands and then say, "molybdic, m-o--l-y-b--d-i-c."

In reading equations aloud, great care should be taken to make sure that the listener gets a clear impression. If the equation is a simple fraction,

$$Y = \frac{A}{B},$$

it is not necessary to point out the numerator and denominator. Just say, "*Y* equals *A* over *B*." But if the fraction has two quantities connected by a plus or minus sign in either the numerator or denominator,

$$Y = \frac{A + B}{C},$$

it should be read: "*Y* equals *A* plus *B* all over *C*" or: "*Y* equals quantity *A* plus *B* close quantity over *C*." It should *not* be read:

"Y equals A plus B over C" since then it could be interpreted as Y equals A plus the fraction B over C,

$$Y = A + \frac{B}{C},$$

which is quite different.

It is always necessary to think in terms of how the result is going to sound to the listener. Consider the following:

$$Y = (A + B)(C + D).$$

It should be read "Y equals quantity A plus B close quantity times the quantity C plus D close quantity." There is another way to read this if one is careful. This is through the use of properly placed pauses as follows: "Y equals A plus B (pause) times (pause) C plus D." Hereafter, when we wish to indicate a pause in the reading, we shall use a series of periods thus: "Y equals A plus B . . . . . times . . . . . C plus D." It is safer, however, to use the quantity method.

Now suppose the equation involves the ratio of two quantities:

$$Y = \frac{A + B}{C + D},$$

Y equals quantity A plus B close quantity over the quantity C plus D close quantity. Again, this may be read: "Y equals A plus B . . . . . all over . . . . . C plus D." One should be careful not to pause in the expression C plus D for fear it will be construed as Y equals quantity A plus B close quantity over C all plus D,

$$Y = \frac{A + B}{C} + D.$$

This should be read as: "Y equals the fraction quantity A plus B close quantity over C, this fraction plus D." Or we might have,

$$Y = A + \frac{B}{C + D},$$

Y equals A plus the fraction B over the quantity C plus D close quantity or

$$Y = A + B\frac{C + D}{C - D},$$

Y equals A . . . . . B times the fraction quantity C plus D close quantity over the quantity C *minus* D close quantity. Here it is necessary to make sure that the listener gets the idea that the numerator is C *plus* D while the denominator is C *minus* D. It is frequently satisfactory if the "close quantity expression" is omitted: "Y equals A plus . . . . . B times the fraction quantity C plus D over the quantity C minus D." Make sure not to pause within the saying of "C plus D" or "C minus D" as they go together to make up the quantities in each case.

There are three ways of writing quantity in equations. These are the brace { }, the bracket [ ], and the parenthesis ( ). The following equation

$$Y = Z\{X + A[B - C(X + Z) - D]\}$$

should be read: "Y equals Z times the brace X plus . . . . . A times the bracket B minus C . . . . . C times the quantity X plus Z close quantity minus D close bracket close brace." Equations do not become as involved as this very often, but when they do, considerable thought should be given to the plan of reading before attempting it.

Grouping by tone of voice or pauses can be very helpful. For example, in reading equations with exponents in them, a pause after the exponent will indicate that what follows is not included in the exponent. Thus

$$Y = A \cdot e^{3\sqrt{x}} + B \cdot e^{-\sqrt{x}} + C,$$

"Y equals A times e to the . . . . . three times the square root of x . . . . . plus . . . . . B times e to the . . . . . minus three times the square root of x . . . . . plus C."

$$Y = e^{-\alpha T}\left[\frac{A}{\sqrt{A^2 + B^2}}\cos \omega T + \frac{B}{\sqrt{A^2 + B^2}}\sin \omega T\right]$$

This equation should be read: "Y equals e to the minus alpha T . . . . . times the bracket A over the square root of the quantity A squared plus B squared . . . . . this fraction times cosine of

omega T . . . . . plus B over the square root of the quantity A squared plus B squared . . . . . this fraction times the sine of omega T close bracket."

Derivatives, integrals, and partial derivatives should be read along these same lines.

$$\frac{dy}{dx}$$

should be read "dy over dx" (don't say "times" between d and y or between d and x). The second derivative,

$$\frac{d^2y}{dx^2}$$

is read: "d squared y over dx squared."

$$\frac{D}{dx}(y^2 + 3)$$

can be read: "D over dx of the quantity y squared plus three." Partial derivatives,

$$\frac{\partial y}{\partial x},$$

are read in a similar fashion: "partial of y with respect to x" is preferred; however, "partial y over partial x" is also correct.

$$\frac{\partial^2 y}{\partial x^2}$$

in this, second "partial of y with respect to x" is preferable to "partial squared y over partial x squared." Integrals such as this,

$$Y = K \int_A^B x^2 \, dx,$$

should be read: "Y equals K times the integral from A to B of X squared dx."

$$Y = \int_0^{\pi} \int_0^R R^2 \sin \theta \, dR \, d\theta,$$

"Y equals the integral from Zero to pi times the integral from *Zero* to R of R squared sine theta . . . . . dR d theta." Or in

$$Y = \int (x^2 - A^2)^{\frac{1}{2}}\, dx,$$

"Y equals the integral of quantity x squared minus A squared close quantity to the one-half power . . . . . dx." Or in

$$Y = \int {}_sB \cdot ds,$$

"Y equals the surface integral of B dot ds." It is well to keep in mind that when in doubt, it is better to put in too many words than not enough. However, a crisp and concise style is to be preferred as this gets the thought across to the listener with a minimum of delay and clutter.

In reading chemical formulas, the subscripts on the elements should not be called sub. For example, water, H_2O, is read "H two O." The letters are not to be read as "capital H" or "capital O" since these extra words do not carry any useful information. Thus, carbon dioxide, CO_2, is read "C O two." Sulfuric acid H_2SO_4, is read "H two S O four."

Sometimes certain compounds, such as $F_e(OH)_3$, contain a group taken some number of times, as in this case OH is taken three times. This may be read "O H . . . . . three or O H three times." Another combination which often appears is COOH. Such frequently occurring combinations may be read as a group separating the group from other elements in the compound by short pauses. $C_{17}H_{35}$ COOH (stearic acid) is read: "C 17 . . . . . H 35 . . . . . C O O H." $CO(NH_2)_2$ would be read: "C O . . . . . NH two . . . . . two." Limonite, $Fe_2O_3 9H_2O$, would be read: "Fe two . . . . . O three . . . . . nine H two . . . . . O." If an equation is written so as to indicate the polarity of the constituents, $Ag^+ + Cl^- = AgCl$, it should be read with appropriate pauses as follows: "Ag plus . . . . . plus Cl minus . . . . . equals Ag Cl." There is a slight chance of confusion in omitting reference to capital and small letters. Carbon monoxide is CO which is read simply "C O." However, cobalt is Co, which could cause trouble. This difficulty arises so seldom that it is better to keep the reading crisp by omitting the word capital and to bear in mind those few combinations that might lend confusion. For example, if one pays no attention to the capitals,

$CaCO_3$, which everyone knows is calcium carbonate, could be interpreted as calcium cobaltite or some equally unheard of compound.

Reading Footnotes and References

Insert a footnote immediately after the sentence in which it occurs unless such insertion interferes with the comprehension of an idea the author is explaining.

> "True fishes first evolved during the Devonian period. Author's footnote: The Devonian is the period of geologic time extending approximately from 280 to 320 million years ago. End of note."

In this instance, the train of thought is not disturbed by the introduction of a footnote. In the following example, the footnote should be read at the close of the paragraph or at some definite break in the thought; and it should be introduced with a phrase that connects it unmistakably with the relevant material.

> "Somewhere far from Egypt, by 3000 B.C., metallurgists learned that if they smelted tin ore and copper ore together, they could produce bronze, harder and more useful than copper and easier to cast. Except for one isolated piece of earlier date (and here the author inserts a footnote), bronze was not brought into Egypt before 1900 B.C., when it probably came through the agency of sea traders from the north or land traders from Palestine. From then on, bronze was a common import. Author's footnote: The isolated piece referred to was a razor containing 8.5 per cent tin, and is the only *proved* exception—though there may of course be others which it has been impossible to certify. End of note."

Be sure to use the words "author's footnote" to distinguish it from *your* editorial remarks, which should be introduced with the words "note to listener."

References to other texts, whether books or magazine articles, are read on the same principle as footnotes, but they are introduced by the words "see" or "consult."

"Consult C. L. Dawes, *A Course in Electrical Engineering,* McGraw-Hill, particularly Chapters 6 and 7."

References to other parts of the text you are recording should be as detailed as possible.

"See page 98, Reel 3, Track 2, first third."

ADDITIONAL AIDS TO RECORDING

PART III

General Suggestions

It is recommended that you study all pertinent material in *Recording Books for the Blind* with particular attention to the sections on "Reading," "Planning a Recording," and "Recording Environment." The section on "Editing" may be of some use but it is not nearly detailed enough in preparing you to record books on science.

If you are not experienced in using a recording machine, or even if you are, try to have a qualified engineer check the following: microphone placement, level, room acoustics, and recording quality. Keep checking back on the recording quality. Often a fine reading job is marred by the poor quality of the reproduction.

Your reading speed should be a little slower than the 165 words per minute recommended in *Recording Books for the Blind*. An average of 150 is about right. Increase speed when the material is simple; slow down for the difficult passages and for formulas, equations, etc.

Now here are some further suggestions intended to help you make your interpretation clear and your reading smooth and thus increase the usefulness of your records.

Set off the reading of formulas, laws, etc., by adequate pauses. A three-second pause after a difficult passage is not too much, and in some cases even a five-second one is desirable. If the listener wishes to go on without stopping his machine, you have allowed him time for comprehension; if he wishes to stop and think, he can go on without losing any of the text. (This would be truer of a disk than of a tape.)

In the case of a reference to a law, a formula, etc., that has been given earlier, repeat the law or formula; e.g., the book reads: "According to Newton's third law (see page 50)"; you read: "According

to Newton's third law that for every action there is an equal and opposite reaction, etc."

Be sure you are emphasizing the right words, figures, etc.; e.g., the sentence "The board is three feet long and three inches wide" should be read "The board is three feet long and three *inches* wide" to underscore the significant distinction which might otherwise be lost.

Be sure that the antecedent of the word *it* or *this* is always perfectly obvious. If, for example, *it* or *this* refers to a law or a formula that was mentioned so far back that it may no longer be in the listener's mind, repeat the law or formula. This is particularly important if the first sentence of a recorded unit contains an *it* or a *this;* e.g., the book reads: "This hypothesis is basic and should be thoroughly understood." You read: "Avogadro's hypothesis that equal volumes of gases under the same conditions of temperature and pressure contain equal numbers of molecules . . ."

Whenever possible, bring a recorded unit to an end at a logical point. Try to leave the listener with a completed thought. If this is not possible, begin the next recorded unit by repeating sufficient material from the end of the last unit to orient the listener.

Be careful in reading parenthetical remarks. Take for example the following enumeration: "the atmosphere (air), the hydrosphere, and the lithosphere." Read as it appears, the listener is likely to think there are four items instead of three. Read it, "The atmosphere, that is air (pause), the hydrosphere, and the lithosphere." Do not say "atmosphere, or air," as this could be taken to mean an additional item. In reading longer parentheses say "parenthesis" at the beginning and "close parenthesis" at the end.

If a problem refers to data used in another problem not immediately preceding, repeat the data so that the listener does not have to search for the other problem.

Be sure that you number every element (figure, problem, table, etc.) that is numbered in the book and that you number it with the *same number*. Read the number *before* the element, e.g., "Problem 12," "Equation 15," and so space the reading that the listener knows that Problem 12 and Equation 15 *follow* upon your announcement of them.

Consult the list of common reading faults in *Recording Books*

for the Blind. Have another person check occasionally to see whether you are committing any of them. Take the trouble to learn whether you are unconsciously doing some of the things that can be distracting to a listener, such as swallowing audibly between sentences or paragraphs, making lip or mouth noises that the mike picks up, swaying, so that your mike "presence" varies, or resting your chin on your hand to the detriment of intelligibility.

It is a very good idea to attach a braille label to each recorded unit. Perhaps you can get a member of your listening audience to cooperate by furnishing the braille information on narrow paper strips. These may be fastened to disk or reel with Duco cement.

Obtaining Permission to Record

Obtaining permission to record is, or should be, the job of the organization producing records—not the job of the individual reader. However, it is in your interest to know that copyrighted material must never be recorded without written authorization.

Should you have the responsibility of obtaining permission, proceed as follows. Write to the *publisher* of the book or article you wish to record. He will not always be the copyright owner but he will probably be authorized to grant recording permission. If he is not, he will refer you to the person who is. Explain that the recording is solely for the use of the blind and, if possible, state the number of blind listeners it is expected to reach. It will be of great help if you can assure the publisher that the recording will *not* be used by sighted persons and that no copies beyond the number he authorizes you to produce will be made. When you have received written permission, you can make up your recorded announcement using the form given in Part II, the section on "Announcements." Be sure your announcement names both publisher and copyright owner and states which of these granted the permission.

APPENDIX A

MAKING BRAILLE DIAGRAMS

Quite frequently some sort of a braille tracing would be a great help to the listener in creating an accurate mental image. Very simple tools are required for this purpose. A regular braille writing stylus and some heavy paper about the thickness and finish of filing cards can be used. In fact, a 4 by 6 card is often large enough. Only in the case of large diagrams or very complex diagrams that require enlarging is it necessary to use larger sheets. The last thing required is a soft surface, such as that provided by a piece of felt perhaps 1/16 inch thick. This felt may, if desired, be tacked to a piece of plywood, measuring about a foot square. All that is required to make the diagram is to place the card on the felt and punch gently with the stylus. Since it is not desirable to make a hole in the card, but just a dot, a great deal of force is not necessary. About eight dots to the inch is satisfactory. (A dressmaker's tracing wheel may be used to make dots, especially where the lines are long and straight. Circles can be made with a special compass equipped with a toothed wheel and obtainable from The Howe Press, Watertown 72, Mass., or a coin may be placed on the paper and dots made around it with the stylus. The size of the circle depends on the amount of detail that is to be displayed.) It must be remembered at all times that the blind listener is going to feel the diagram on the raised dotted side, and hence the diagram from his point of view will be reversed (left for right) from what is drawn. If the diagram is symmetrical, it will not be necessary to make any allowance for this reversal. In making an impression of a graph, however, the reversal must be taken into consideration.

It is often necessary to braille only a portion of a diagram—that part that would be very difficult to explain in words without the braille aid. If it is at all possible, a few braille letters should be put on the diagram to help the listener follow the spoken word. These letters may be written either with a braille pocket slate, available

from the American Foundation for the Blind, or in freehand with the stylus. This freehand writing may be done on the felt surface. The American Foundation for the Blind or the local agency for the blind can supply a card that contains the braille alphabet together with the corresponding printed letters. A little practice is all that is necessary to become sufficiently proficient for these simple braille markings. (It is not necessary to attain perfection in the braille drawings. Neatness and clarity are the only requirements.) Be sure to mark each card or sheet with some identifying label such as the figure number of the book being read.

Occasionally, a diagram is too complicated either to explain without a braille aid or to be put into a single braille diagram. In this case, it may be desirable to present two or three braille diagrams, each representing a portion of the entire figure. The words in the recording should explain the braille diagrams and integrate them into the overall picture.

The making of braille aids to the recording must not be considered as a chore but rather as a means of making easier the job of explaining the printed material. For example, it would take a great number of words, indeed if it is even possible, to create a mental impression of the sine wave shown in Figure 4. But with

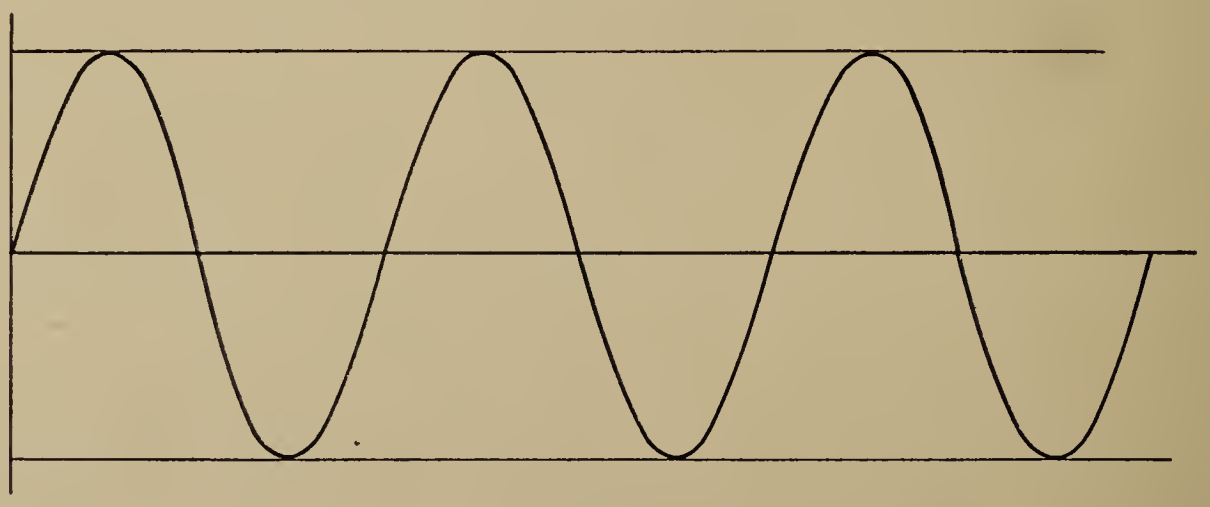


FIGURE 4.

the diagram in braille relatively few words will give all the information required. Brailling should, however, be resorted to only when absolutely necessary because in most cases it is quicker to plan and say the words than it is to make a dotted sketch.

APPENDIX B

PUTTING GRAPHS, DIAGRAMS, AND STRUCTURAL FORMULAS INTO WORDS

Graphs

Since a graph is usually presented for the purpose of showing a general trend it is often sufficient, in making your explanation, merely to indicate the trend without giving every last detail of the graph as it appears in the text.

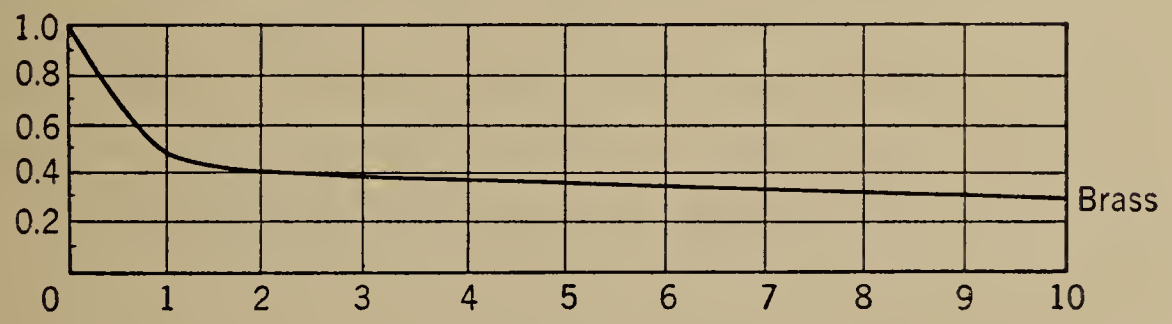


FIGURE 5.

Figure 5, for example, may be summarized as follows:

> "For a brass ball bouncing on a heavy steel plate the coefficient of restitution (r) is plotted on the vertical axis, and the velocity of approach, in meters per second, on the horizontal axis. The curve is shown starting at r equals 1 and velocity of zero meters per second and dropping rapidly to point four seven at a velocity of one meter per second, then down to point four for velocity of three meters per second, and finally down to point three one for a velocity of ten meters per second."

This description indicates clearly, without going into details about the ordinates, the abscissas, or the numerical values, that the curve drops rapidly at first and has very little decrease between three and ten meters per second. (Be careful about the use of "*Y*"

and "X" for vertical and horizontal and also about the use of the terms "ordinate" and "abscissa," since some of your listeners may not know their meaning. They do not have ready access to a dictionary and they cannot easily look back through the book being read for a definition of terms.

In talking about graphs such terms as "sloping from upper left to lower right" or "going downward to the right" are often helpful. A curve might be described as convex upward which means bulging upward. Or it might be concave upward which means that the curve would hold water. Or the curve is convex to the right which means that it bulges toward the right, or it is concave to the right, etc. Sometimes a rough braille sketch on a card, together with the word description, avoids confusion. (Suggestions for making such sketches are given in Appendix A.)

If the reader wishes to use a term that has not been in common use throughout the book, he should give a quick explanation of the meaning. For example, if the reader wishes to point out that the curve falls in the third quadrant but the word quadrant has not appeared in the reading, he should say something like, "If a horizontal and a vertical line are drawn so that they cross at their centers at right angles, such as is the case here, the area above the horizontal and to the right of the vertical is known as the first quadrant, and the other three quadrants are numbered in counterclockwise order: the second is to the left of the vertical; the third is the area below the horizontal and to the left of the vertical, and the fourth is below the horizontal and to the right of the vertical." The term "approaching asymptotically" might be described as "approaching rapidly at first and then more and more gradually."

Explaining a family of curves can be more difficult. For example, a family of plate current versus plate voltage with grid voltage as a parameter for triode vacuum tube would be exceedingly complicated to describe, but something like the following could be said: "This is a family of curves showing plate current plotted against plate voltage for various values of grid voltage. The curve corresponding to zero grid volts starts at 1 milliampere for zero plate voltage and rises to 50 milliamperes at 150 volts. It is curved near the origin but straightens at about 10 milliamperes at 20 volts. The other curves are approximately parallel to this one.

For example, a curve corresponding to -20 volts on the grid starts at 0 plate current and 50 volts then rises to 50 milliamperes at 350 volts."

Diagrams

In describing electrical diagrams, give a brief description of the physical layout before starting to describe the actual connections. Then give the circuit in logical sequence and be careful to avoid expressions that could be confusing. If the circuit is complex, it may be desirable to identify points in the diagram by attaching letters to them. These letters probably will not appear in the printed copy. As these letters are assigned by the reader, they should be penciled in so as to avoid confusion.

Consider the simple circulit shown in Figure 6. One might say:

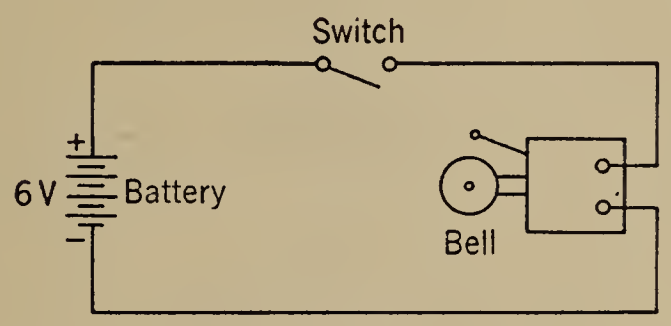


Figure 6.

"This circuit shows a battery on the left connected through a switch to a bell on the right. There is a wire going from the negative terminal of a 6-volt battery to one terminal of the bell. A wire goes from the positive terminal of the battery to one side of the switch. The other side of the switch is connected to the other terminal of the bell." Or you could say that the positive terminal of the battery is connected through a switch to the other terminal of the bell. If it is a diagram for a beginner, this might be somewhat confusing because the listener might not know what is meant by "is connected through a switch." In this case, the first suggestion is better. One should *not* say "the positive terminal of the battery goes to a switch and then to the other terminal of the bell." This could mean that the wire goes from the battery to one side of the switch and then to the

bell with the other side of the switch unaccounted for as shown in Figure 7. This is one of the most common mis-

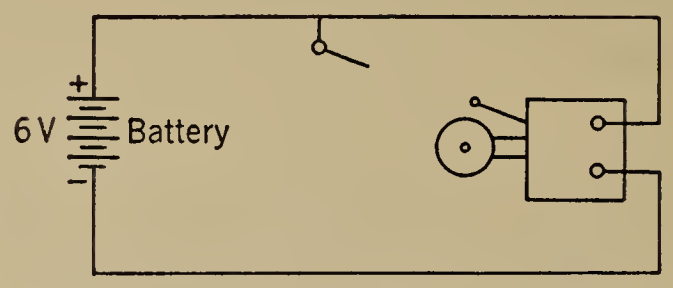


FIGURE 7.

takes made by sighted people attempting to describe a circuit. It is very important to say "through" or mention both terminals.

Consider the common bridge circuit shown in Figure 8. Since

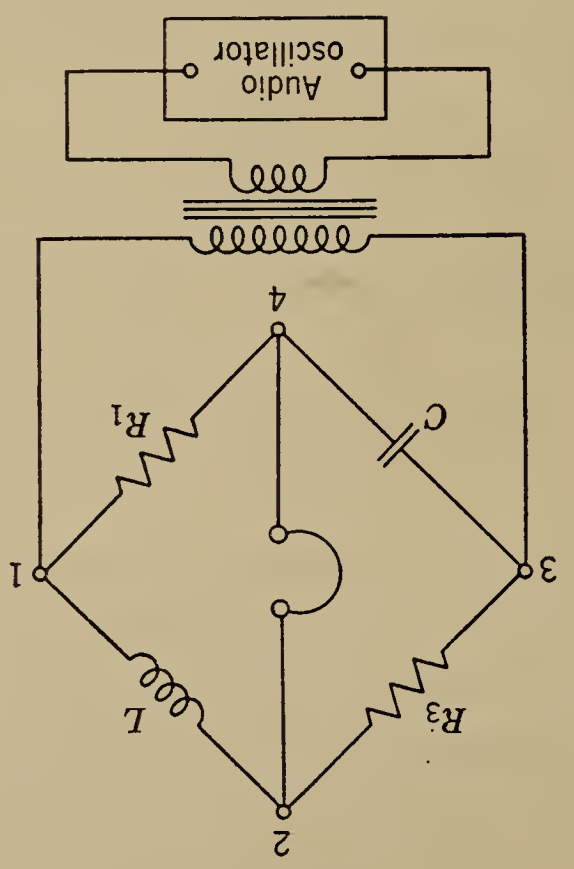


FIGURE 8.

it is drawn in the form of a baseball diamond, there is no harm in using this image in the description. Most every one knows enough about the game to recognize the term. Or the reader can number the corners of the diamond and then refer to these numbers. For example:

> "Let us designate first base as one, second base as two, third base as three, and home base as four. Between four and one

is a resistor R_1; from one to two there is a coil (or inductance) L; between two and three is a resistor R_3, and from three to four is a capacitor C. An audio oscillator is connected to the primary of a transformer. The secondary of this transformer is connected to terminals one and three. A pair of earphones is shown connected between terminals two and four." The last sentence might be expressed in another way: "A pair of earphones is shown with one lead connected to terminal two and the other to terminal four."

A simple vacuum tube amplifier is diagrammed in Figure 9. The diagram might be described as follows:

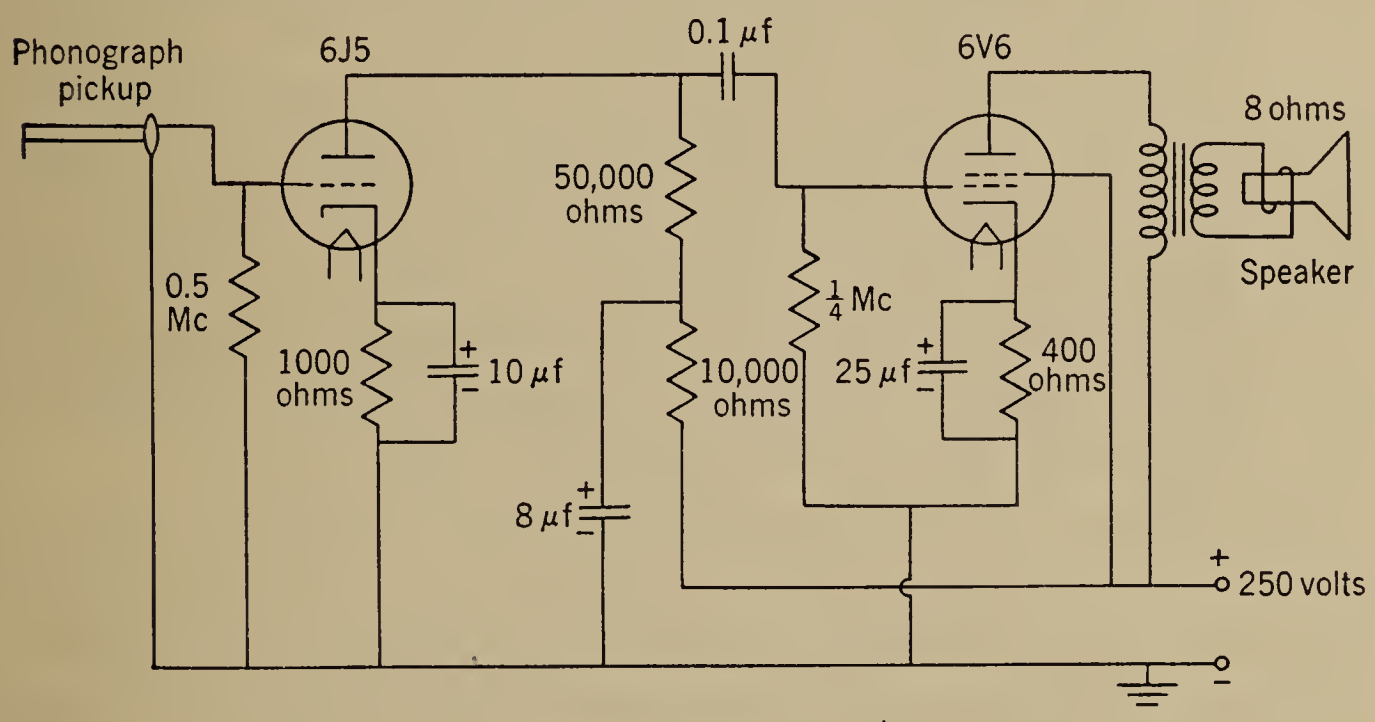


FIGURE 9.

"One side of the phonograph pickup is connected to the grid of the triode vacuum tube type 6J5. The other side of the pickup is grounded. There is a point-five-megacycle resistor connected between the grid and the ground. (This could also be worded: There is a point-five-megacycle resistor across the pickup, or in parallel with the pickup.) The cathode of the tube is connected to one end of a thousand-ohm resistor, the other end of which goes to ground. Connected in parallel with this resistor is a ten-microfarad electrolytic capacitor with the positive terminal toward the cathode. The plate of the tube goes through two resistors in series to the plus terminal of the power supply marked 250

volts. The first resistor (nearest the plate) is fifty thousand ohms and the other is ten thousand ohms. The positive terminal of an eight-microfarad electrolytic capacitor is connected to the junction of these two series resistors. The other terminal of the capacitor is connected to ground. The plate is also connected to one side of a point-one-microfarad capacitor, the other end of which goes to the grid of the next tube which is a type 6V6. A quarter-megacycle resistor is connected between this grid and ground. The cathode of the six V six goes through a four-hundred-ohm resistor and a twenty-five-microfarad capacitor in parallel to ground. Again the positive terminal of the capacitor is toward the cathode. The screen grid of this tube is connected to 250 volts plus. The plate of the tube is connected to one side of the primary of the output transformer. The other terminal of the primary is connected to 250 volts plus. The secondary of the transformer is connected to the loudspeaker marked eight ohms. The negative terminal of the power supply is connected to ground. The tube filaments are connected to a source of 6 volts AC."

In using the expression "the plate goes" it helps to think of where the current flows. That is, the plate current flows through the two resistors in series to the plus of the power supply. It is not necessary to try to keep track of the direction in which the current flows but only to use the thought to assist in phrasing. If a ground or negative *B* supply is shown, make it a terminus for all connections that go to ground. Do not say, for example, that the cathode of tube 6V6 goes through a resistor to ground and then through another resistor to the grid of the 6V6. This is a possible path, but it is not the correct interpretation. Both resistors go to ground. If the reader is not sure of how the circuit works and hence is unable to make valid judgments of this kind, the circuit could be explained as follows:

> "The plate of the 6J5 is connected to one end of a fifty-thousand-ohm resistor. The other end of this resistor is connected to one end of a ten-thousand-ohm resistor. The other end of this resistor goes to plus 250 volts. To the wire

between the fifty- and ten-thousand-ohm resistors is a wire going to the plus terminal of an eight-microfarad electrolytic capacitor. The other terminal of this capacitor goes to ground. To the wire between the plate and the end of the fifty-thousand-ohm resistor there is a wire going to one end of a point-one-microfarad capacitor. The other end of this capacitor goes to the grid of the 6V6, and between the capacitor and the grid is connected one end of a quarter-megacycle resistor. The other end of this resistor goes to ground."

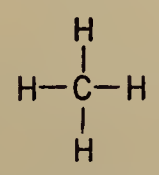
This method may require more words, but the listener can obtain a very clear picture of the circuit. After all, this is the desired result.

In describing circuits containing ganged multi-positioned switches it is necessary to letter the switch sections *A, B, C,* etc., and the switch positions 1, 2, 3, etc. The moving contact is generally called the arm and the fixed contacts are frequently called poles. It is necessary to point out very clearly leads that are connected to the arm as opposed to leads connected to the poles. Since the circuit element connected to the arm is the part of the circuit being switched, it is usually desirable to establish this part of the switching circuit first.

The above specific examples are intended as illustrations of methods for explaining electrical circuits in general.

Structural Formulas

Structural formulas in chemistry should be read with considerable care. For example, consider the structural formula for me-



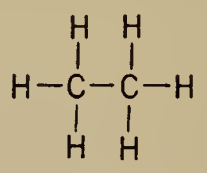
(a)

Methane

thane. The symbolic formula is C H four (this may be written as CH_4 for purposes of this handbook in order to save space). The structural formula might be described as follows:

"A carbon atom C is surrounded by four hydrogen atoms H. One H atom is above the C, one to the right, one below, and one to the left of the C. Each of these H atoms is connected to the C atom by a single bond. Thus, there are four bonds for the carbon atom and one for each hydrogen atom."

The structural formula for ethane, C_2H_6, might be described as follows:

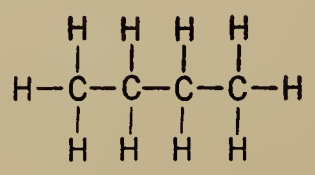


(b)

Ethane

"This molecule contains two carbon atoms arranged side by side with a single bond between them. There are three H atoms associated with the left-hand C, one above, one to the left, and one below. Each is joined to the C with a single bond. There are three more H atoms associated with the right-hand C, one above, one to the right, and one below, again each joined to the C with a single bond. Thus, each C atom has four bonds and each H atom has one."

Hydrocarbon structural formulas can become complicated with resultant difficulty in word description. Consider two forms of C_4H_{10}, butane and isobutane. The structural formula of butane is read:



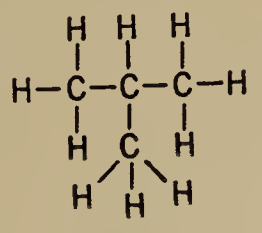
(c)

Butane

"There are four carbon atoms arranged in a straight line from left to right with a single bond between each. A hydrogen atom H is above and below each carbon atom, each connected to the carbon atom by a single bond. An H atom is also to the left of the left-hand C atom and is joined to it by a single bond. An H atom is also to the right of the right-hand C atom and is joined to it with a single bond.

Thus, there are four C atoms and 10 H atoms, and each C atom has four bonds associated with it."

The other form of butane, called isobutane, is arranged somewhat differently. It can be described thus:

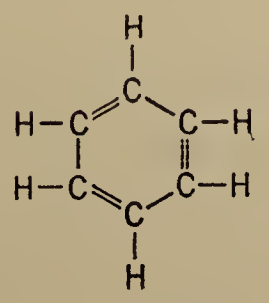


(d)

Isobutane

"There are three C atoms in a horizontal line, each joined by a single bond. Below the middle C atom is another C atom joined to the C above by a single bond. Above this middle C atom is an H atom joined to it by a single bond. The left-hand C atom has three H atoms, each bonded to it by a single bond, one above, one to the left, and one below. The right-hand C atom similarly has three H atoms bonded to it, each by a single bond, one above, one to the right, and one below. Each of these three C atoms has the required four bonds, but the C atom that is below the middle one has only one. Thus, below this C atom there are three H atoms arranged in a straight line from left to right, each joined to the C atom in question by a single bond. The lines representing these three bonds fan out from the C atom and go to the three H atoms below."

The organic compound benzene is more complicated. The formual, C_6H_6, is read C six H six. The structural formula for

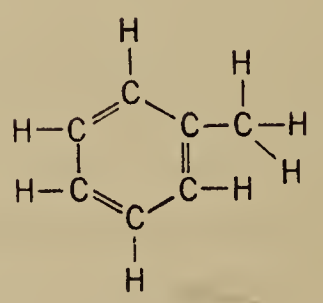


(e)

Benzene

the benzene ring, as shown, "takes the shape of a hexagon standing on one point. There is a carbon atom at each of

the six corners of the hexagon. The upper atom shall be designated 1, the next one to the right 2, etc. In other words, the atoms are numbered in the clockwise sense starting with 1 at the top. Between 1 and 2 there is a single bond, between 2 and 3 there is a double bond, between 3 and 4 a single bond, between 4 and 5 a double bond, between 5 and 6 a single bond, and between 6 and 1 a double bond. That is, the bonds are single, double, single, double, etc. Around the outside are six H atoms—one opposite each corner and connected to the associated C atom by a single bond. Thus each C atom has its required four bonds, and each H atom has one bond."



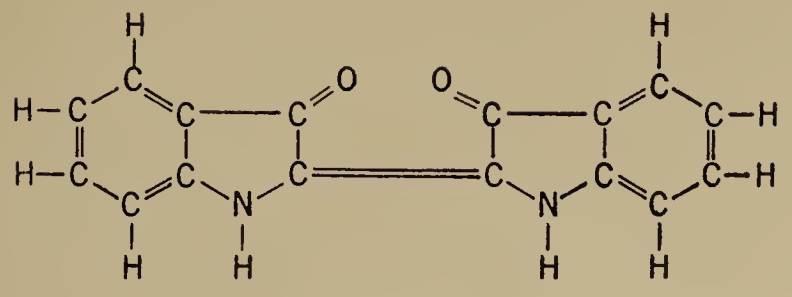
(f)

Toluene

"Toluene, C_7H_8, is just like the benzene molecule except that the H atom associated with the number 2 C atom has been replaced by a CH_3 group. That is, the number 2 C atom is joined by a single bond to another C atom that is located in the position of the corresponding H atom of the benzene ring. This additional C atom has associated with it three H atoms each of which is joined to it by a single bond. Thus there are seven C atoms and eight H atoms."

It will be observed that in the preceding discussion of the hydrocarbons, the development has been from the simple type to the more and more complex, with previous descriptions used as building blocks as it were. Progressive descriptions of this type aid the reader by reducing the amount of material which must be repeated.

As a last illustration, consider the structural formula of indigo, $C_{16}H_{10}N_2O_2$.



(g)

Indigo

"It consists of two benzene rings, number one on the left and number 2 on the right. The atoms of carbon in each ring are numbered as for the benzene ring. The left-hand ring has H atoms bonded to the C atoms at positions 1, 4, 5, and 6. The right-hand ring has H atoms bonded to the C atoms at positions 1, 2, 3, and 4. This accounts for the necessary four bonds to all the C atoms except numbers 2 and 3 in the left ring and 5 and 6 in the right ring. As the rings are shown, the C atom 2 of the left ring is opposite 6 of the right, and C atom 3 is opposite 5. The rings are separated far enough to diagram the structure that joins the two rings. The connecting structure is as follows: Carbon atom number 2 of the left-hand ring is joined by a single bond to another C atom that we shall call C-2 prime. This atom is to the right of C-2. Above C-2 prime is an oxygen atom joined to it by a double bond. Under C-2 prime and joined to it by a single bond is another C atom C-3 prime. C-3 prime is to the right of C-3. Between C-3 and C-3 prime is a nitrogen atom N. This N atom is bonded by a single bond to C-3 prime and by another single bond to C-3. Below N there is an H atom joined to it by a single bond. Thus, this N atom has three single bonds associated with it. All the atoms of carbon associated with the left half of the indigo molecule have their required four bonds except C-3 prime which has only two thus far. Carbon atom C-6 in the right-hand ring is joined to a carbon atom C-6 prime by a single bond. This atom is to the left of C-6 and is opposite C-3 prime mentioned above. C-6 prime is joined by a dou-

ble bond to an oxygen atom O which is located above it. Below C-6 prime is C-5 prime, joined to it by a single bond. C-5 prime is opposite C-3 prime. Between C-5 prime and C-5 is a nitogren atom N. This N atom has two single bonds, one to C-5 and one to C-5 prime. Below this N atom is an H atom joined to it by a single bond. All the carbon atoms of the right-hand ring have the required four bonds with the exception of C-5 prime, which has only two. It will be remembered that atom C-3 prime in the left half also lacks two bonds. There is a double bond between C-3 prime and C-5 prime thus completing the molecule."

Although this sounds like a very complicated description, it must be remembered that the listener is expected to listen to the description several times and to mull over the mental image long enough to get it firmly in mind. An attempt to assist the formation of the desired image by drawing a diagram on reasonably heavy paper by punching dots would not be amiss. This punched diagram should not replace words, but supplement them. Choose words and phrases carefully to avoid ambiguity in the mind of the listener and provide frequent three- or four-second pauses at key points to enable the listener to establish a mental impression. Keep in mind that it is desired to create the correct result, not to save words and recording time. However, the reading should be crisp and attention-holding.

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